Temperature determination from ion time-of-flight measurements in short-pulse laser produced plasmas†

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Abstract

The hydrodynamics and electron temperature evolution in intense femtosecond laser produced plasmas are examined in numerical simulations and experiments on the USP laser facility at LLNL. Lasnex simulations in one and two dimensions are used to model the plasma expansion for long times after the laser pulse. Results indicate that the asymptotic velocities of ions from various depths in the target depend strongly on the sound speed near the heat propagation front. Ion time-of-flight data from buried layer targets are then used to probe the electron temperature in this hot dense region as a function of depth in the target. For intensities near 3×10^{17} W/cm^2 we determine a peak electron temperature near 500 eV in solid density Al. A simple impulse model based on solutions to the hydrodynamic equations is shown to be in qualitative agreement with the full simulations. We will also discuss the effects of different energy transport models on the calculations and show, for example, that including a hot electron component results in better agreement with velocity measurements for deeper material.

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